Assignment VIII : Object-Oriented Programming and Perceptron

April 24, 2025

ID5002W: Industrial AI Laboratory

Total Marks: 80

Instructions

1. Assignment shall be submitted before the due date. Late submissions will not be entertained. If you cannot submit the assignment due to some reasons, please contact Dr. Tirthankar by email.
2. All the assignments must be the student's own work. The students are encouraged to discuss or consult friends or classmates. However, they have to submit their own work. Any malpractice will be reported to the authorities and action will be taken as per the IIT Madras rules.
3. If you find the solution in the book or article or on the website, please indicate the reference in the solution
4. Submission instructions:
   - *You are expected to submit a single jupyter/ipython notebook.*
   - *Answer only Problem 2 in a report in pdf format. For problem 1 and problem 3, only the code is sufficient.*
   - *For plots, use the plt.show() command.*
5. Please note:
   - Code should execute without any error.
   - The code should be clean with readable comments.
   - The output of the code should be in a relevant format so that it can be understood by an evaluator.

Problem 1

Consider the instances (x, y) along with the corresponding class labels given below:

Instance	Class Label
$(0, 0)$	0
$(0, 1)$	0
$(1, 0)$	0
$(1, 1)$	1

(a) Run the perceptron algorithm to find a line that separates the two classes. Do not do a train-test split. All four data points are your training data and there is no test data. [**Marks:5**]

(b) In a single figure, plot the four data points (put a different color for the two classes), the decision boundary $\mathbf{w}.\mathbf{x} + b$ (the output of the perceptron algorithm) that separates the two classes, and the weight vector $\mathbf{w}$ that is perpendicular to the decision boundary. [**Marks:15**]

Problem 2

Answer each question briefly in a report. (*maximum 5 sentences*)

(a) Is the output of the perceptron algorithm unique? If the output is unique, explain why it is unique. If the output is not unique, explain why it is not unique. [**Marks:10**]

(b) Would you set the learning rate to a high value or to a low value in the perceptron algorithm ? Explain your rationale in terms of geometry. [**Marks:10**]

Problem 3

The dataset for this problem is the breast cancer dataset from sklearn. Use the following code to load the dataset:

```
import sklearn.datasets
import pandas as pd
breast_cancer = sklearn.datasets.load_breast_cancer()
df = pd.DataFrame(breast_cancer.data, columns=breast_cancer.feature_names)
df['class'] = breast_cancer.target
# Add "class" column that stores the binary class labels
```

(a) Create a class pcpt_hptune which is a child of the perceptron class. The __init__ method should load the breast cancer dataset from sklearn and create an attribute "self.df" which contains the entire DataFrame. [**Marks:5**]

(b) Create a function in the class pcpt_hptune with name "hptune" for hyperparameter tuning. Use 5 different values *each* for learning rate and epochs. The function should print the best learning rate and numbers of epochs. The data is the breast cancer dataset from sklearn. [**Marks:20**]

(c) Create a function in the pcpt_hptune class that takes as input the optimal weight and bias values obtained in part (b) and then displays a scatter plot of the values (all elements of $\mathbf{w}$ and the bias b). [**Marks:10**]

(d) Create an instance of the pcpt_hptune class and execute all the functions. [**Marks:5**]